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NURSING BOTTLE

CROSS REFERENCE TO RELATED APPLICATION

This invention is a continuation-in-part of U. S. Application Serial No. 08/511,590 now US Pat. No 5570796 by Craig E. Brown and Robert J. Brown, the disclosure of which is hereby incorporated by reference.

FIELD OF THE INVENTION

This invention relates to nursing bottles. More particularly, this invention relates to nursing bottles having an air vent to prevent the creation of a vacuum inside the bottle that could make it more difficult for an infant to suck liquid from the bottle.

BACKGROUND OF THE INVENTION

Babies are born with the instinct to suckle milk from their mothers' breasts, but it is often necessary for them to drink liquids from other sources. Babies are unable to drink liquids from glasses or cups without spilling so it is common throughout the world to feed liquids to babies in nursing bottles, also known as baby bottles. A nursing bottle features a rubber nipple with a small hole in its tip secured across an opening in the top of a liquid container. A nursing bottle is used by filling the container with liquid, securing the nipple, inverting the bottle, and placing the nipple into the baby's mouth. The baby then sucks on the nipple to withdraw the liquid.

A conventional nursing bottle is tightly sealed except for the small opening in the nipple. As the baby nurses, the liquid volume inside the bottle decreases and the air volume increases. However, ambient air is unable to enter the bottle so a partial vacuum is created inside the bottle. The partial vacuum, in turn, impedes the flow of liquid out the nipple and forces the baby to suck harder to withdraw the liquid. As the baby sucks harder on the nipple, ambient air inadvertently and inevitably enters the baby's mouth and

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stomach. Excessive air in the stomach and other parts of the alimentary canal causes colic, a condition characterized by abdominal discomfort and pain. See generally O.P. Mathew, *Science of Bottle Feeding*, The Journal of Pediatrics, October 1991, 511; and W.R. Treem, *Infant Colic*, Pediatric Clinics of North America, October 1994, 1121.

Many attempts have been made to provide a nursing bottle with an air vent to enable ambient air to enter the container during use. For example, Roderick, U.S. Pat. No. 598,231, issued Feb. 1, 1898, discloses a nursing bottle having a U-shaped air tube. One end of the tube communicates with the top of the container interior while the other end communicates with the ambient air outside the bottle. When the bottle is inverted, liquid rises into the tube and impedes the flow of air into the interior of the container. If the bottle is placed upright quickly, the liquid in the tube does not have a chance to drain and it remains in the tube. When the bottle is again inverted, the liquid spills out the end of the tube which communicates with the ambient air. Other nursing bottles with air vents are disclosed in Van Cleave, U.S. Pat. No. 927,013, issued Jul. 6, 1909; Davenport, U.S. Pat. No. 1,441,623, issued Jan. 9, 1923; and Perry, U.S. Pat. No. 2,061,477, issued Nov. 17, 1936. None of these nursing bottles completely solves the problem of venting the interior of the bottle at atmospheric pressure while preventing leaks and spills. Accordingly, a demand still exists for a nursing bottle which prevents the formation of a partial vacuum inside the bottle during nursing and yet resists spills.

SUMMARY OF THE INVENTION

The nursing bottle of the present invention provides a nursing bottle which prevents the formation of a partial vacuum inside the bottle during nursing, yet resists spills. The nursing bottle is easy to clean and prevents the formation of a partial vacuum without requiring gaskets.

Moreover, an embodiment of the present invention provides a nursing bottle having a vent unit which is adapted to fit inside the bottle.

Generally, the nursing bottle of the present invention comprises a container adapted to contain a quantity of liquid and having an opening at its top for the reception of a nipple; a vent unit adapted to fit within the container comprising a vent tube having an upper and lower portion, the vent tube having an open end projecting sufficiently downwardly into the container, an airway in the vent unit extending between the outside of the container and a point in the vent tube above the level of liquid trapped in the vent tube when the nursing bottle is inverted, the lower portion of the vent tube having a volume less than that of the upper portion so that, when the container is filled with liquid and inverted, the liquid from the lower portion only partially fills the upper portion, and the airway and vent tube allow atmospheric air to flow into the bottle to prevent the formation of a vacuum inside the bottle when liquid is withdrawn. Accordingly, liquid continues to flow freely through the nipple and the baby nursing from the bottle is much less prone to swallow air and develop colic. The nursing bottle of this invention completely eliminates the possibility of leaks and spills when used properly and it is easy to clean.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective, exploded view of one embodiment of the, nursing bottle of this invention;

Fig. 2 is a sectional elevational view thereof;

Fig. 3 is a sectional view taken along plane 3-3 of Fig. 2;

Fig. 4 is a sectional view taken along plane 4-4 of Fig. 2;

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Fig. 5 is a sectional view similar to that shown in Fig. 2, but with the nursing bottle in the inverted, feeding position;

Fig. 6 is a sectional elevational view of a second embodiment of the nursing bottle of this invention;

Fig. 7 is a sectional view taken along plane 7-7 of Fig. 6;

Fig. 8 is a sectional view taken along plane 8-8 of Fig. 6;

Fig. 9 is a sectional view similar to that shown in Fig. 6, but with the nursing bottle in the inverted, feeding position;

Fig. 10 is a sectional elevational view of a third embodiment of the nursing bottle of this invention;

Fig. 11 is a sectional elevational view of a fourth embodiment of the nursing bottle of this invention;

Fig. ~~12~~ 1 is a perspective view of a first ~~fifth~~ embodiment of a nursing bottle constructed according to the principles of this invention;

Fig. ~~13~~ 2 is a front plan view of the nursing bottle of the first ~~fifth~~ embodiment;

Fig. ~~14~~ 3 is a sectional front plan view of the nursing bottle of the first ~~fifth~~ embodiment;

Fig. ~~15~~ 4 is a sectional elevational view of the nursing bottle of the first ~~fifth~~ embodiment shown in the inverted, feeding position;

Fig. ~~16~~ 5 is a perspective, exploded view of the nursing bottle of the first ~~fifth~~ embodiment; and

Fig. ~~17~~ 6 is a perspective view of a second ~~sixth~~ embodiment of a nursing bottle constructed according to the principles of this invention;

Fig. ~~18~~ 7 is a front plan view of the nursing bottle of the second ~~sixth~~ embodiment;

Fig. ~~19~~ 8 is a sectional front plan view of the nursing bottle of the second ~~sixth~~ embodiment;

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Fig. ~~20~~ 9 is a sectional elevational view of the nursing bottle of the ~~sixth~~ second embodiment shown in the inverted, feeding position;

Fig. ~~21~~ 10 is a perspective, exploded view of the nursing bottle of the ~~sixth~~ second embodiment; and

Fig. ~~22~~ 11 is a bottom plan view of a vent cap of the nursing bottle of the ~~sixth~~ second embodiment.

Corresponding reference numerals indicate corresponding parts throughout the drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This invention is best understood by reference to the drawings. ~~Figs. 1-5 show the first embodiment of the~~ nursing bottle 100 of this invention. The nursing bottle contains three components, a container 110, a liquid conduit-reservoir 120, and an air conduit-flange 130. Each of these three components is discussed below. The three components are separate and capable of easy disassembly and reassembly for ease of cleaning. A conventional nipple cap 500 is shown in phantom lines in Figs. 1, 2 and 5. Although the nipple cap is not part of the nursing bottle of this invention, it is attached to the nursing bottle before use. The nipple cap includes a rubber or silicone portion 510 containing one or more small holes 511 in its tip through which the liquid flows when the baby sucks. The nipple cap also includes a collar portion 520 with internal threads for attaching the nipple cap to the bottle. The term "nipple" is used herein, as the context requires, to refer to the rubber portion of a nipple cap, to the entire nipple cap, and to any type of protruding member with a restricted opening designed to be held inside the mouth during use.

The container is adapted to hold a quantity of liquid 140 at its bottom and a quantity of air 150 at its top when in the vertical position. As discussed more fully below, the liquid level in the container does not exceed a predetermined level. In Fig. 1, the maximum liquid level is

shown by a line 111 permanently marked on the side of the container. This marked line is typically at or about the point of communication between the liquid conduit and the reservoir. An air space exists above the liquid. The container is typically cylindrical in shape, i.e., it has a height several times greater than its diameter. The container preferably has a diameter of about 3 to 8 cm so it can be held easily by the small hands of babies. If desired, detachable or permanent handles are added to the container. The container is preferably rounded throughout all or most of its circumference. In the first embodiment shown in Figs. 3 and 4, the container is circular in cross-section throughout approximately three-fourths of its circumference. The other one-fourth of the circumference is relatively flat. In contrast, other embodiments are circular or polygonal in cross-section for most of their heights.

The container has a threaded neck 112 adapted to receive a standard nipple cap. The neck is typically located at or about the radial center of the container (as viewed from the top). The container has an internal volume of about 0.05 to 1 liter and is constructed of a rigid or semi-rigid material such as glass or plastic. Suitable plastics include polypropylene, polycarbonate and polyethylene (both low-density and high-density). The container preferably has some means for visually determining the liquid level. The container is preferably transparent or translucent so the liquid level can be viewed through the container. Alternatively, the container may be opaque and include a slit or series of ports through which the interior can be viewed. The first embodiment shown in the Figs. 1-5 contains a protruding portion 113 at its bottom. A tube 114 rises from, and communicates with, the protruding portion. The tube has a height of about 1-2 cm and a diameter of about 0.5 to 1 cm. As discussed below, the tube can be

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considered an extension of the liquid conduit when the components are assembled.

Another component of the nursing bottle embodiments one through four shown in Figs. 1-11, is the liquid conduit-reservoir. Although the liquid conduit-reservoir is molded as a single piece, it is best considered as two separate elements - a liquid conduit 121 and a reservoir 125. When the nursing bottle of the first four embodiments shown in Figs. 1-11 is assembled for use, the liquid conduit-reservoirs fit onto the tube of the containers by frictional fit. The frictional fit is sufficient to provide a seal and thereby prevent liquid from escaping. More specifically, the liquid conduit begins at a point 122 near the bottom of the container, i.e., within about 1 to 5 cm of the bottom. This point is preferably in the container's air space when inverted, as best seen in Fig. 5. The other end 123 of the liquid conduit communicates with the bottom of the reservoir. Thus, when the bottle is upright and contains liquid, liquid enters the conduit and reaches the same level as in the container. The primary purpose of the vertical liquid conduit is to provide a portion of a passage for ambient air into the container when the bottle is inverted and the liquid contents are being withdrawn through the nipple. Accordingly, the cross-sectional area of the liquid conduit need not be very large, an area of about 5 to 75 sq. mm is adequate. While not critical to this invention, the liquid conduit of the preferred embodiment is tapered inwardly from top to bottom. This taper facilitates the flow of liquid into the reservoir by minimizing capillary action when the bottle is inverted.

The reservoir is located such that substantially all its volume is above the maximum liquid level. In the embodiment shown in Figs. 1-5, the reservoir is adjacent to the air space at the top of the container. This location ensures that the reservoir is substantially free of liquid when the container is filled with liquid and in the upright,

vertical position. The reservoir retains liquid from the liquid conduit and thereby prevents liquid from leaking through the open end of the air conduit. The volume of the reservoir is greater than the volume of the liquid conduit so that, when the bottle is inverted, it can hold whatever liquid is in the conduit and while maintaining an air space. Although there is no maximum size for the reservoir, the reservoir preferably has a volume less than about one-fourth of the volume of the container. The reservoir communicates with the liquid conduit at a point at or above the level of liquid in the container and conduit. If the liquid level is substantially above this point of communication, there is a danger that the reservoir may contain too much liquid when the bottle is inverted and, as a result, liquid could spill out the open end of the air conduit. The point of communication between the liquid conduit and reservoir is large enough and shaped to ensure that any liquid flowing down the liquid conduit when the bottle is inverted enters the reservoir. The shape of the reservoir is not critical, provided it tapers downwardly to the liquid conduit so that little, if any, liquid is retained in the reservoir when the nursing bottle is returned to the upright position. In the first embodiment shown in Figs. 1-5, the reservoir is pear-shaped. However, other shapes, such as spherical and cylindrical, are also suitable. A threaded neck 126 is located on top of the reservoir for attaching it to the air conduit-flange.

The air conduit-flange is another component of the nursing bottle. The flange portion 131 is adapted to fit over the threaded neck of the container. The flange is secured in position when the nipple cap is screwed tightly onto the threaded neck. The air conduit-flange has a protruding shoulder 132 which extends out and over the liquid conduit-reservoir. A member 133 with internal threads descends from the shoulder and is adapted to mate with the threaded neck on top of the reservoir. Two pegs

134 preferably extend downwardly on either side of the member. When the nursing bottle is assembled, the pegs butt against the container, as shown in Fig. 3. Although not essential, the pegs help secure the air conduit-flange and the liquid conduit-reservoir in position by restricting any lateral movement.

The air conduit 135 descends into the center of the reservoir. The air conduit has openings at each of its ends. The top opening 136 is located in the shoulder portion and communicates with ambient air. The bottom opening 137 is located near the bottom of the conduit and is located so that it is in the reservoir's air space when the bottle is inverted, as seen in Fig. 5. It can be seen that the bottom opening is preferably located on a radially-outward point of the air conduit to minimize the possibility of liquid entering the air conduit when the bottle is inverted.

~~A fifth~~ The first embodiment of this invention is shown in Figs. ~~12-16~~ 1-5. The bottle 600 of this ~~fifth~~ first embodiment comprises a conventional container 602, having an open top 604, surrounded by a threaded neck 606. The bottle 600 also includes a conventional nipple 608 that can be secured with a threaded ring-shaped collar 610 to the container. However, bottle 600 also comprises a vent unit 612 interposed between the container 602 and the nipple 608-collar 610 assembly.

The vent unit 612 comprises a reservoir tube 614 having a first end adjacent the top of the bottle 600, and an open second end projecting sufficiently downwardly in the container that when the bottle 600 is inverted, the second end is above the liquid level in the inverted container. The vent unit 612 further comprises a vent insert 616 which abuts between the reservoir tube 614 and nipple 608. The vent insert 616 prevents liquid from entering an airway while allowing air to flow from the reservoir tube 614 through the airway. The insert 616 includes curved slots

620 to permit liquid to flow through the insert from the interior of the container 602 to the nipple 608. The vent unit airway 618 extends between the outside of the bottle 600 and a point in the reservoir tube 614 above the level of the liquid trapped inside the vent tube when the bottle 600 is inverted. Thus, the airway 618 and the end of the reservoir tube 614 connect the air space that forms above the liquid when the bottle is inverted with the atmosphere, thereby preventing the formation of a partial vacuum inside the bottle as liquid is drawn through the nipple.

As best shown in the figures, the upper portion 622 of the reservoir tube 614 preferably has a much larger cross-sectional area than the lower portion 624, to more easily accommodate the liquid trapped in the lower portion of the vent tube when the bottle 600 is inverted.

The vent unit 612 has a threaded collar 626 for securing the unit on the threaded neck 606 of the container 602. The top of the unit 612 has external threads 628 on which the conventional collar 610 and nipple 608 can be secured. The passageway extends from an opening in the side of the vent unit 612 to vent tube 630 that projects downwardly into the upper portion 622 of the reservoir tube 614. The vent tube 630 projects sufficiently into the upper portion 622 of the reservoir tube 614 so that the distal end of the vent tube is above the level of the liquid that is trapped in the reservoir tube when the bottle 600 is inverted. There is an opening 632 in the distal end of the vent tube. The opening is fairly small, and is preferably in the side of the vent tube, to help prevent liquid from escaping through the airway 618.

In use, the container 602 is filled with a liquid and the vent unit is inserted into the container, and screwed onto the threaded neck 606 of the container. The ring-shaped collar 610 and nipple 608 are then screwed onto the vent unit 612. As shown in Fig. 15, when the assembled bottle 600 is inverted so that an infant can suck the liquid

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from the nipple, some of the liquid is trapped in the reservoir tube 614, and this liquid flows to the upper portion 622 of the reservoir tube. Because of the size of the upper portion 622 of the reservoir tube, and the length of the vent tube 630, the upper end of the vent tube, and in particular the opening 632 in the lower end of the vent tube, is above the level of the liquid trapped in the inverted reservoir tube. Thus there is a continuous air path from outside the bottle through the vent tube and through the lower portion of the reservoir tube to the air space in the top of the bottle. This allows atmospheric air to replace the volume of fluid sucked through the nipple, preventing the creation of a partial vacuum that would make it difficult for the infant to draw fluid from bottle.

A ~~sixth~~ second embodiment of the nursing bottle of this invention, indicated generally as 700, is shown in Figs. ~~17-22~~ 6-11. The bottle 700 includes a container 702 having an open top 704 surrounded by a threaded neck 706. The bottle 700 also includes a conventional nipple 708, that can be secured with a threaded ring-shaped collar 710. A vent unit 712 is interposed between the top of the neck and the nipple, and extends into the container 702. The vent unit 712 comprises a vent insert 714, a reservoir tube 716 depending from the insert, and a vent tube 718 depending from the insert inside the reservoir tube.

The insert 714 comprises a generally cylindrical sidewall 720 having a flat circular top surface 722 against which the nipple 708 can seal, and a circumferential groove 724 at the bottom of the sidewall adapted to engage and seal with the top of the neck 706 of the container. There are curved slots 726 in the insert 714 to permit liquid to flow through the insert from the interior of the container 702 to the nipple 708.

A hollow conduit 728 extends diametrically across the insert 714, communicating with openings 730 in the exterior of the sidewall 720. There is a tubular extension 732

depending from the underside of the insert 714. The extension 732 is within the curved slots 726, so that it does not interfere with flow of liquid through slots in the insert. The extension 732 is internally threaded. There is an opening 734 generally in the bottom of the insert 714, inside the extension 732, that communicates with the conduit 728.

The reservoir tube 716 has an upper section 736 and a lower section 738. The upper portion of the upper section 736 is externally threaded to engage the interior threads in the extension 732. The reservoir tube 716 extends downwardly into the container 702 sufficiently so that when the bottle 700 filled with liquid is inverted, the open lower end of the reservoir tube is above the level of the liquid in the inverted bottle. The upper section 736 has a larger cross sectional area than the lower section so that the upper section can easily accommodate the volume of fluid that the lower section can hold.

The vent tube 718 comprises a short cylindrical section 740 having an large annular flange 742 at its upper end 744, and a rounded closed lower end 746. The vent tube 718 fits in the extension 732, with the upper end of the reservoir tube 716 holding the flange 742 against the bottom of the insert, and thereby sealing the vent tube against the bottom of the insert 714. There is a small opening 748 in the lower end 746 of the vent tube 718, preferably on the side of the vent tube adjacent the bottom. The vent tube 718 projects sufficiently into the reservoir tube 716 so that when the bottle 700 filled with liquid is inverted, the lower end 746 of the vent tube, and more specifically the opening 748, is above the level of the liquid trapped in the reservoir tube 716. Thus the vent unit 712 provides an airway between the exterior of the bottle and a point in the reservoir tube that is above the level of the liquid trapped in the reservoir tube when the bottle is inverted. However, the vent tube 718 preferably does not project so far that it

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is below the level of the liquid in the reservoir tube 716 when the bottle 700 is upright.

The vent unit 712 provides air to the interior bottle 700 so that when an infant sucks liquid from the bottle, the volume is replaced, preventing the creation of a partial vacuum inside the bottle that would make it increasingly difficult for the infant to suck liquid from the bottle.

In operation the vent unit 712 is assembled by placing the upper end of the vent tube 718 into the extension 732, and then threading the threaded upper portion of the upper section 736 of the reservoir tube 716 into the internal threads on the extension 732. The container 702 is filled with a liquid, such as water, juice, or milk. The vent insert 714 is then placed on the top of the neck 706 of the container, with the groove 724 seating against and sealing with the top of the neck. The nipple 708 is placed over the top of the insert 714 and the collar 710 is threaded onto the threads on the neck 706 to compress the nipple against the circular seat on the insert, and to compress the insert against the top of the neck.

The infant can easily suck the liquid in the bottle through the nipple, the liquid flowing freely through the slots 726 in the insert from the interior of the container. When the bottle is inverted to draw liquid through the nipple, some of the liquid is trapped in the reservoir tube 716. This liquid flows into the upper section 736. Because of the relative sizing of the upper section 736 and the lower section 738, and the length of the vent tube 718, the end of the vent tube is above the level of the liquid trapped in the reservoir tube 716, providing a continuous air path from the exterior of the bottle to the air space above the liquid in the inverted bottle. As the liquid is sucked from the inside of the container, it is replaced with air that passes between the threaded collar 710 and the threads on the neck 706, through the openings 730 into the air conduit 728, and from there through the opening 734 into

the vent tube 718 through the opening 748 in the end of the vent tube, and through the reservoir tube 716 to the air space above the liquid in the inverted bottle. This prevents the formation of a vacuum in the bottle.

In operation, the nursing bottle of this invention is assembled to provide a container preventing the formation of a vacuum inside the container when liquid is withdrawn during use. ~~In the first embodiment, the liquid conduit-reservoir is attached to the air conduit-flange by screwing the threaded neck 126 into the descending member 133. These two components are then connected to the container by slipping the flange down and over the container's neck 112 while simultaneously guiding the liquid conduit onto the tube 114. The container is then partially filled with liquid. The liquid level should not substantially exceed the marked fill line, i.e., the point of communication between the liquid conduit and the reservoir. As previously discussed, if the liquid level substantially exceeds the point of communication, there is the danger of liquid spilling out the opening when the bottle is inverted. In Fig. 2, the liquid level is about 5 mm below the point of communication. The nipple is then secured to the container and the bottle is ready for use.~~

~~When the bottle is inverted, the liquid conduit-reservoir is maintained in a position facing upward, as seen in Fig. 5. This position ensures that: (1) all the liquid from the liquid conduit flows into the reservoir; (2) no additional liquid enters the conduit; and (3) ambient air is free to enter the interior of the container by flowing through the air conduit, the air space in the reservoir, and the liquid conduit. Thus, a~~ A vacuum is prevented from being formed in the interior of the bottle during use and the baby nursing from the bottle is not forced to suck so hard that air is inadvertently swallowed. As a result, the chances of colic are greatly reduced.

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A second embodiment of the nursing bottle of this invention is shown in Figs. 6-9. The bottle 200 contains the same components and functions the same as the preferred embodiment, but differs from the preferred embodiment in two primary ways. First, this embodiment cannot be disassembled for cleaning. Second, the liquid conduit 221, the reservoir 225, and the air conduit 235 are all located inside the container 210. Referring to Fig. 9, it can be seen that it is very important that the liquid conduit-reservoir-air conduit face upward when the bottle is inverted so that no liquid flows into the air conduit. If the bottle were inverted incorrectly, liquid would flow down the air conduit and spill out through opening 235.

Fig. 10 illustrates a third embodiment of the nursing bottle of this invention. The nursing bottle 300 is very similar to the bottle shown in Figs. 6-9. The primary difference is that the air conduit 335 is simply an opening in the upper wall of the container.

A fourth embodiment of the nursing bottle of this invention is shown in Fig. 11. This bottle 400 differs from the second and third embodiments in that the liquid conduit 421, the reservoir 425, and the air conduit 435 are all outside the container 410. They are, however, connected to the container.

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Figs. ~~12-16~~ 1-5 illustrate a ~~fifth~~ first embodiment of the nursing bottle of this invention. ~~The~~ In bottle 600 ~~differs from the first through fourth embodiments in that~~ the vent unit 612 is interposed between the container 602 and the collar 610 and nipple 608 without having extensions protruding outside of the bottle.

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A ~~sixth~~ second embodiment of the nursing bottle of this invention is shown in Figs. ~~17-22~~ 6-11. The bottle includes a container 702 having an open top 704 surrounded by a threaded neck 706. The bottle also comprises a ring-shaped collar 710 adapted to secure a conventional nipple 708 on the container. The bottle also comprises a vent unit 712

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interposed between the top of the neck and the nipple, and extends into the container 702. When the container is inverted, the liquid from the lower portion of the vent unit 712 flows into the upper portion and no additional liquid enters the vent unit. Thus, atmospheric air is free to enter into the container by flowing from outside the bottle through the vent unit 712. Thus, a vacuum is prevented from being formed within the interior of the container during use and a baby nursing from a bottle is not forced to inadvertently swallow air so that the chances of colic are reduced.

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